that all highlights are properly and thoroughly studied at the time of the event for posterity, enables direct comparison of one period with another on a more accurate basis. This is because only one observer is involved who becomes familiar with, and develops a sixth sense for, the climatological and meteorological peculiarities of his immediate environment which no new observer taking over can expect to know at the outset.

When supported by radio-teleprinter, facsimile and morse-instant synoptic and upper-air data, duly charted and available on an almost daily basis back to September 1955 in the case of the present author, the reader can appreciate that the longer one's own climatological record is maintained, the more useful it becomes in doing practical forecasting work for one's own area. In effect, the whole subject is brought to life and the hour or so spent every day of one's life observing and entering instrumental and visual readings becomes less and less of a chore the longer one persists. It is hoped that some would-be amateurs reading this will take the hint.

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A METEOROLOGICAL EXPLANATION FOR SOME OF THE MYSTERIOUS SIGHTINGS ON LOCH NESS AND OTHER LAKES AND RIVERS

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The saga of the Loch Ness monster is one of compelling interest for scientists and laymen alike. If the 'monster' should ever prove to be a previously-unknown aquatic animal, it would be a triumph for the zoologists who establish the truth via a live specimen or corpse. But if, as is more probable, no such monster has survived from prehistoric times, the saga at any rate appears to have the resources necessary for surviving a long time into the future. This is due to proven characteristics of human nature, for the monster hunt has long since acquired the stature of the interminable search for unidentified flying objects (UFO's).

Several books have been written about unusual happenings in Loch Ness and other inland and maritime waters[1—6]. A search of Scottish folklore and histories has brought to light additional and much older stories of unexplained phenomena. Whenever a rational explanation has not been forthcoming, the monster has often received the credit for being the cause of the event or at the foundation of the legend. As a result, the list of unexplained lake phenomena (ULP) has lengthened substantially due to the vagueness and incompleteness of many of the accounts. A further limitation to interpreting correctly eye-witness or historic descriptions is provided by the present-day limit of one's knowledge of natural, physical and biological phenomena. The purpose of this article is to introduce into the discussion of puzzling lake apparitions a meteorological phenomenon which has not been considered by previous writers on Loch Ness monsters. This is the so-called water-devil or water-whirlwind, and its occurrence will be shown to explain a particular class of previously unidentified lake phenomena very well. At the same time, some of the legends appear to be explicable in terms of waterspouts or tornadoes.

WATER-DEVILS AND WATERSPOUTS

From photographs and drawings, *waterspouts* are familiar to everyone as funnel-shaped clouds which extend downwards from storm-clouds and which disturb the water surface in a violent commotion of spray. In well-formed cases, the hollow spout may be seen as a continuous link between the storm-cloud and the water surface, but in lesser examples a continuous connection may not be apparent, especially to a swimmer or a boatman who has been unexpectedly overwhelmed by one. Waterspouts are bad-weather phenomena. If they strike the shore or lake-side, they take on the role of a tornado and can be severely damaging. Many dozens of British examples, with references, are in the files of the Tornado and Storm Research Organisation[7]. In 1975 there were 9 separate marine cases of waterspouts in Britain[8] and in 1974 there were at least 11[7].

Water-devils are less familiar atmospheric phenomena, although their whirlwind counterparts over the land, known as land- or dust-devils, are common in the warmest half of the year. Dust-devils frequently develop in fine situations, especially on hot, sunny days, and if they should happen to move on to an adjacent water surface they become water-devils. Alternatively, dust- and water-devils can form on fine days which are not necessarily warm when the surface-level mass of air is overrun by a cooler air-mass, as from an advancing sea-breeze or other micro-front. In fact, water devils can raise so much spray or can cause such a stir in the water that it is easy to understand why some people have assumed the cause to be animate.

Several examples of water-devils on inland British waters have been described in the meteorological literature. A photograph of two on Rydal Water, near Windermere, is in *Nature*[9]. A recent occurrence on Buttermere Lake, on a fine day in July 1972, was related to me by the witness who watched it progress from the land to near the centre of the lake. The following description from Aberdeenshire, Scotland, is of interest because, if it had not been seen by a weather observer[10], it could have been claimed to be the effect of a great denizen rising from the depths.

> 'The 2nd June (1779) sitting by the water we saw a pillar of water rise as high as the tallest tree, and fall down again, after which it rolled along for a considerable space in large rolls as if a cask had been under the water, (and out of those rolls sprung up small strings of water, rising pretty high, as out of the strup of a razor)—The noise it made was such as a firework of powder makes when first set off, but much louder. The day was clear, fine sunshine and not a breath of wind'.

Sometimes devils make a noise described as a roar or like muffled thunder or the sound of a gun[11]; at other times, only a gentle swishing is heard

and this may be inaudible to a distant onlooker. This second illustration comes from the River Elwy, near St. Asaph, North Wales (6 April 1872)[12]:

> 'My attention was suddenly called by a remarkable strange hissing bubbling sound . . . (to) . . . a diminutive waterspout in the centre of the stream, some 40 paces from where I was standing. Its base was a little more than 2 feet in diameter. The water curled up from the river in an unbroken cylindrical form to a height of about 15 inches, rotating rapidly, then diverged as from a number of jets, being thrown off with considerable force to an additional elevation of 6 or 7 feet, the spray flying all round as from an elaborately arranged fountain, covering a large area. It remained in the same position for about 40 seconds, then moved slowly . . . The day was fine and sunny . . . The event occurred about 1215, and lasted 70 or 80 seconds . . . '

We shall now consider a few of the accounts which are taken from books on the Loch Ness monster and which are better understood in terms of water-devils or water-spouts.

ST. COLUMBA AND THE WATER MONSTER

The oldest of these accounts is described in the books of E. M. Campbell[2] and T. Dinsdale[6]; the quotation is from the former reference.

> 'There is a well-known passage in St. Adamnan's Life of St. Columba headed 'Of the driving away of a certain water monster by virtue of prayer of the holy man' which records an encounter with the monster in about A.D. 565. Strictly speaking it probably took place in the River Ness, which joins the loch (Loch Ness) to the sea.
>
> 'St. Columba found some men burying the corpse of one who was said to have been savagely attacked by a water monster. The saint directed one of his followers to swim across the river and this provoked a second attack; the monster 'rushed up with a great roar and open mouth' to within a few feet of the swimmer.
>
> St. Columba calmly raised his hand, made the sign of the cross, called on the name of God and commanded the monster to retreat. At the sound of his voice it obeyed, going away faster than it had approached. The swimmer returned safely to land amid much rejoicing.'
>
> Whether there is any truth at all in this story we shall never know. St. Adamnan himself went to considerable pains to emphasise that his informants were men of integrity and that he himself would never have given credence to an unreliable report. It seems likely that the story may have had a basis in fact, used and embellished to produce proof of the saint's power to bring about a victory of good over evil; . . . No factual report has ever referred to a loch creature attacking a man or making any sound at all, let alone a roar . . . '

With our modern knowledge of water-devils, we suggest that St. Adamnan came very near indeed to relating the facts correctly, but that for 'monster' we should read 'devil' in the meteorological sense[13]. The saint's account is then the oldest description (for the British Isles) of a fair-weather water-devil, the roar being the key point of the description. Notice the logical train of thought—the water-devil made a roar (as they do), therefore it had an open mouth, therefore it was a monster. Nor should one overlook the fact

that observational detail was sometimes erroneous in olden times because of imperfect eyesight, spectacles being practically unknown until the sixteenth century.

An indication of the intensity which water-devils can attain is suggested by the strength known to have been reached by land-devils. Last year, on 30 June 1975, a land-devil tore the roof from a newly-constructed stores building and hurled it 60 yards on to a car (*J. Met.*, no 1, p. 32). Such a devil, if moving across a water surface, might well 'savagely attack' a swimmer and cause him to drown.

SOME OTHER TALES AND LEGENDS

On p 170 of Dinsdale's first edition of *The Loch Ness Monster*[3], a legendary water-serpent called Ogopogo from Lake Okanagan, British Columbia is described. This lake is much bigger than Loch Ness, being some 70–80 miles in length.

> 'Chief Timbashet . . . proceeded up the lake by the shortest possible route. Approaching the rocky point . . . , waves were suddenly seen to arise around the canoe and in a fury of foam and spray, the Chief and his family disappeared—and were not seen again. The other Indians . . . knew at once that N'ha-a-itk (or Ogopogo) . . . had whipped up the engulfing waves by lashing with his tail.'

This, and similar stories, was intended to provide indirect support for the existence of inland water monsters. However, such stories are surprisingly common across the world, the reason for which is probably the comparatively high frequency of storms and waterspouts (they are much more commonplace than monsters) and the occasional resulting fatality.

Waterspouts form the basis of Arabian tales of tinnin or sea-monsters, which are the same as the Hebrew Tannin (E.V. whale, dragon)[14]. In Malagasy, a waterspout is called Rambondanitra, or tail of the sky. On the Mendip Hills in Somerset, tornado funnel clouds are known as dragon's tails[15]. Chinese folk-lore attributed storms to dragons, especially, one would imagine, those storms possessing dragon tails. Miss Botley says that the squall-prone lakes of Kashmir were traditionally held to contain mysterious monsters[16]. A discussion of the great sea-serpent of Lake Victoria Nyanza in the context of water-spouts over the lake has been given by S. and E. B. Worthington[17], from which Miss Botley took the following quotation[16]:

> 'It announces its coming with a terrible roar and emerges from the lake at certain times to swallow up human beings, canoes and everything in its path'.
>
> The authors then make the point that if a waterspout should pass nearby 'the surface must rock and heave . . . as though disturbed by some enormous creature about to break surface, and men must have been completely overcome from time to time with no trace remaining of man or boat, as though all had been completely swallowed. Small wonder that the myth has come into being of the terrible monster which announces its coming with a roar and consumes men and boat alike'.

This type of incident may be able to account for a night-time disaster which took place in a Scottish loch in the sixteenth century when all the inhabitants of a small island perished. The following account, recorded by Timothy Pont about 1590, is to be found in Holiday[6] as a suggested example of a loch-monster 'blundering about a small island at night'.

> 'Ardgoure next to Lochaquber on the eist syd of Lochaquber. In this little countrie of ancient there were certaine Inhabitants . . . and they did build ane house of timber in ane litle Illand which was among Mosses next to the principall toune which they had in Ardgoure. And the said Inhabitants having this Illand for ane streng house to keep the principall men and their kin and friends from enemies. They being dwelling there for ane space, it fortuned on a tyme that ane monstrous beast being in that litle Logh, the most pairt of these Inhabitants being in this Illand, it was overwhelmit and destroyed by that terrible and most fearful Monstrous beast, and so they all were perished and devoured'.

It would need an enormous monster to lay waste an entire island, including people, huts and fortifications, but the disaster is entirely within the capability of a storm with tornado-strength winds. Hundreds of examples of such storms have been collected for Britain (ref. 7, pp. 24–27), and, if the numbers are relatively low for Scotland, it is partly because of the low population density in much of the country away from the southern lowlands. The most recent example of a Scottish waterspout, which occurred in the Moray Firth in November 1975, is described in the *Sunday Post* of 30 November by Mr. A. Gowrie of Buckie:

> TERRIFYING SIGHT IN THE MORAY FIRTH: Recently we had a fairly strong north-east wind in the Moray Firth. As I looked out to sea, I blinked at what I saw. It appeared to be a column, 150 feet high and 100 feet in diameter, about a mile and a half out. It was spinning at terrific speed with the base on the sea like a boiling cauldron. It moved fast from east to west towards Lossiemouth. Then, after travelling about two miles, the spectacle suddenly vanished. As it did, I thought of fishing vessels which might have been lost with all hands. I don't think anything could survive being struck by such a lump of water[18].

By similar reasoning, it is quite possible that the origin of numerous Scottish legends concerning water-horses, kelpies, and other apparitions lies in historic observations of waterspouts and water-devils involving incidents like the ones related above; but there is not the space to consider these stories on this occasion, and we conclude by discussing some Loch Ness observations reported in the past 50 years.

LOCH NESS MONSTER, 1930 and 1933—but was it a devil?

This next observation was made by Mr. I Milne on a fine calm evening in 1930 while fishing in Loch Ness. It was first printed in the *Northern Chronicle* on 14 June 1933 and reprinted by T. Dinsdale in the *Loch Ness Monster,* ref. 3, p. 163.

> '—we heard a terrible noise in the water and looking round we saw about 600 yards distant a great commotion, with spray flying everywhere. Then the fish—or whatever it was— started coming towards us and when it was about 300 yards away it turned to the right and went into Holly Bush Bay and disappeared in the depths. During its rush it caused a wave about 2½ feet, sufficient to rock the boat. My opinion is that it is an enormous eel, about 20 feet long.'

This report, and the next, sound remarkably like good water-devil descriptions. Unfortunately, the next one was related second-hand, i.e. not by the eye-witness. This is probably why a 'body' was put into the middle of the water-devil's spray, because no other agent could be imagined as the cause. The event took place ¾ mile from the shore, and was reported in the *Northern Chronicle* on 3 May 1933 (Dinsdale, ref. 3).

> 'A man and wife were startled to see a tremendous upheaval in the water which had previously been as calm as the proverbial millpond; then the creature disported itself rolling and plunging for more than a minute, its body resembling that of a whale, the water cascading and churning like a simmering cauldron: soon however it disappeared in a boiling mass of foam. The onlookers confessed there was something uncanny about the whole thing, for they realised that here was no ordinary denizen of the depths because apart from its enormous size, in taking the final plunge, the creature sent out waves that were big enough to have been caused by a passing steamer . . . '

References 2 to 6 contain hundreds of examples of unidentified lake phenomena. A few would appear to be lesser cases of the ones cited here, for instance ones which are the consequence of curious eddy or other effects resulting from the interaction of wind and water. Most of the other sightings require quite different explanations, involving, as examples, the motion of common aquatic birds and animals or of logs, flotsam, or decaying vegetable or animal matter[1]. From time to time, some entirely new ideas will be introduced which will explain away a few per cent of the past observations. Nevertheless, it is clear that as long as any observations remain unexplained there will be some persons who will be prepared to search for monsters.

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THE VALUE OF RADIO-TELEPRINTER TRANSMISSIONS FOR AMATEUR METEOROLOGISTS AND FORECASTERS

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If you have ever been in an R.A.F. station, or in an airport met room, and watched teleprinters churning out masses of weather data via a land-line system which seemed to require rack upon rack of electronic equipment and two Post Office engineers fighting to keep it going, you may be surprised to learn that you can get all this information using simple equipment housed in a small garden shed—or on a table in your study if you are not distracted by the steady pattering of the teleprinter.

What is more, there is only the initial cost of the equipment to consider (apart from buying paper rolls for the teleprinter occasionally)—there would not be any land-line charges to pay for this service as all information comes in by radio.

Most of the major weather centres throughout the world have a radio-teleprinter transmitter, and all the broadcasts are under the supervision of the World Meteorological Organisation. They are principally there to act as a back-up service in case of land-line failure, or to serve places where physical conditions make the provision of a land-line impossible.

As far as the British Isles are concerned, the main source of data is from a broadcast radiated by GFL which originates from Bracknell. Recently this broadcast has been converted to computer control and this has resulted in better time-keeping of scheduled data.

Bracknell transmits the following observations for the British Isles.

United Kingdom — List 1 (14 *stations*)

005 — Lerwick
026 — Stornoway
100 — Tiree
171 — Leuchars
222 — Carlisle
302 — Valley
334 — Ringway
377 — Waddington
586 — Honington
715 — Rhoose (Glamorgan Airport)
772 — Heathrow
797 — Manston
817 — St. Mawgan
917 — Aldergrove

United Kingdom — List 2 (16 *stations*)

017 — Kirkwall
022 — Benbecula
066 — Kinloss
091 — Dyce
135 — Prestwick
204 — Ronaldsway
240 — Boulmer
257 — Leeming
396 — Kilnsea
496 — Gorleston
502 — Aberporth
534 — Elmdon
603 — Brawdy
804 — Scilly
827 — Plymouth
862 — Hurn

United Kingdom — List 3 (11 *stations*)

075 — Wick
140 — Abbotsinch
160 — Turnhouse
162 — Eskdalemuir
318 — Squiresgate
360 — Finningley
414 — Shawbury
559 — Cardington
740 — Lyneham
776 — Gatwick
839 — Exeter

Ireland — List 1 (2 *stations*)

953 — Valentia
976 — Belmullet

Ireland — List 2 (6 *stations*)

955 — Cork
957 — Rosslare
962 — Shannon
965 — Birr
969 — Dublin
980 — Malin Head

Ireland — List 3 (5 *stations*)

952 — Roches Point
960 — Kilkenny
970 — Claremorris
971 — Mullingar
974 — Clones

Much to the dismay of many U.K. users of the Bracknell transmission, the stations listed above are considerably fewer in number than was the case up to 1964. Between 1964 and early 1975 about 65 reports were received for the British Isles. This number has now been reduced still further to only 54 stations whereas the Admiralty List of Radio Signals, Volume 4, lists almost 300 places reporting in the synoptic network of the British Isles—many of these on an hourly basis while the radio-teleprinter broadcast only sends out information at three-hourly intervals.

The surface weather reports for U.K. land stations include the following data: wind speed and direction, visibility, present weather, past weather, pressure readings in millibars reduced to sea-level (QFF), temperature in °C., types of high, medium and low cloud, dew point, barometric tendency and characteristic in the past 3 hours, temperature extremes and rainfall, cloud heights and amounts, and any special phenomena.

In addition to Bracknell's three-hourly surface reports for the British Isles, Scandinavia, Europe, European Russia, Iberia, Iceland and Greenland, there are surface reports every six hours for a few stations in Eastern U.S.A., Eastern Canada and Bermuda, ship reports (mostly from the Atlantic) as and when available, and aircraft reports: upper air reports—in detail from the British Isles and Scandinavia, with summarised information from the rest of Europe; thunderstorm location reports on an hourly basis; surface analysis from the West Atlantic to European Russia at 1030, 1630, 2230 and 0430; forecast analysis at 1035, 1635, 2235 and 0435; and monthly climatological reports on the 4th of the month for the British Isles, Holland, weather ships and Gibraltar for the preceding month.

In fast-moving situations it is advisable to turn to the M.O.T.N.E. (Meteorological Operational Teleprinter Network Europe) broadcast, which is controlled from Vienna. This transmission updates weather information from 22 major British Isles airfields every half-hour. Terminal airport forecasts are also available and in difficult synoptic situations it can be reassuring to read these. Warnings of thunderstorms, clear air turbulence, and other flying hazards also appear—a most essential broadcast for members of the international jet set.

The following stations are covered by the M.O.T.N.E. broadcast.

EGLL—London/Heathrow
EGKK—London/Gatwick
EGSS—Stansted
EGMC—Southend
EGNT—Newcastle/Woolsington
EGNV—Teesside Airport